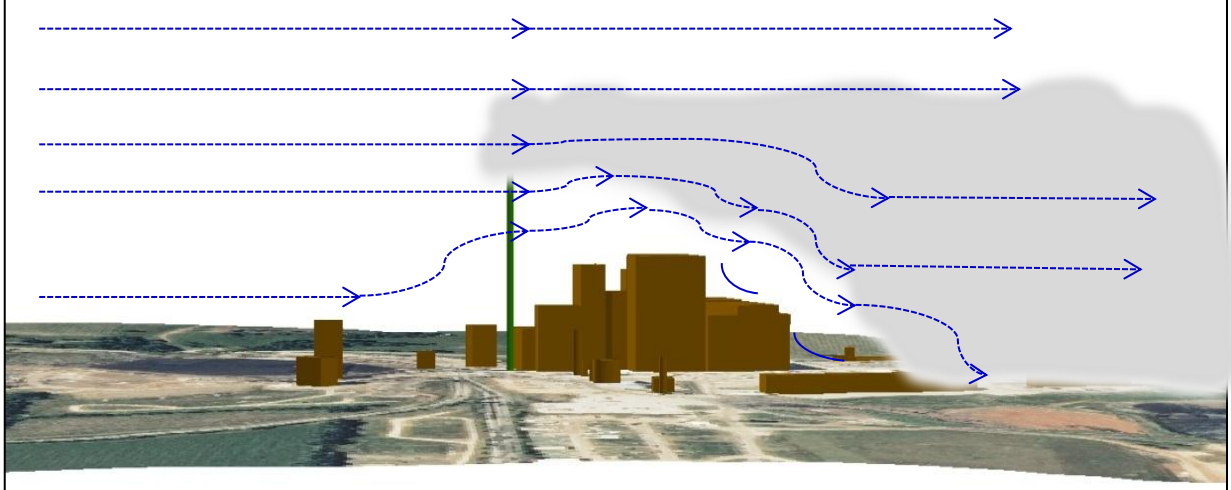
Building Downwash & Good Engineering Practice Stack Height

The presence of buildings can affect plume rise and the initial dispersion of pollutants within the atmosphere. Turbulent wake zones can be created around buildings that force pollutants to the ground instead of allowing them to rise freely within the atmosphere. Building downwash occurs as the wind flows over and around buildings and impacts the dispersion of pollution from nearby stacks, refer to Figure 1, entitled "Simplified Building Downwash Depiction."

Figure 1
Simplified Building Downwash Depiction



In order to avoid excessive downwind concentrations due to building downwash effects, the height of the stack must be tall enough to allow the emissions plume to escape the cavity region that is created on the downwind side of a building complex, a height that is referred to as good engineering practice (GEP) stack height. According to Section 123 of the Clean Air Act, GEP is defined as "the height necessary to insure that emissions from a stack do not result in excessive concentrations of any air pollutant in the immediate vicinity of the source as a result of atmospheric downwash, eddies or wakes which may be created by the source itself, nearby structures or nearby terrain obstacles."

In addition to defining GEP stack height, Section 123 of the Clean Air Act required the Environmental Protection Agency's Administrator to implement GEP stack height regulations in order to ensure that compliance with the air quality standards continued to be demonstrated without consideration of the portion of the stack that exceeded GEP stack height or any other dispersion technique prohibited under

the act such as merging gas streams, intermittent controls, etc. The stack height regulations are contained within 40 CFR 51.1 and define GEP as the greater of:

1. 65 meters, measured from the ground-level elevation at the base of the stack,
2. Hg = 2.5H, if the stack was in existence on January 12, 1979,
3. Hg = H +1.5L, all other stacks,
4. Any stack built prior to December 30, 1970 is grandfathered and is exempt from the GEP stack height requirements.

Where:

- Hg = good engineering practice stack height, measured from the ground-level elevation at the base of the stack,
- H = height of nearby structure(s) measured from the ground-level elevation at the base of the stack,
- L = lessor dimension, height or projected building width, of nearby structure(s), and
- Projected building width is the maximum length of a building that could affect air flow around and over the structure.

When determining compliance with the air quality standards, the stack height must be less than or equal to the GEP stack height within the model input file. ***It is important to note that GEP does not limit the physical height of the stack, but limits the credit that can be given for that portion of the stack that exceeds GEP.*** For a detailed discussion on the GEP stack height requirements, please refer to the Environmental Protection Agency's technical support document entitled "Guideline for Determination of Good Engineering Practice Stack Height Technical Support Document for the Stack Height Regulations."

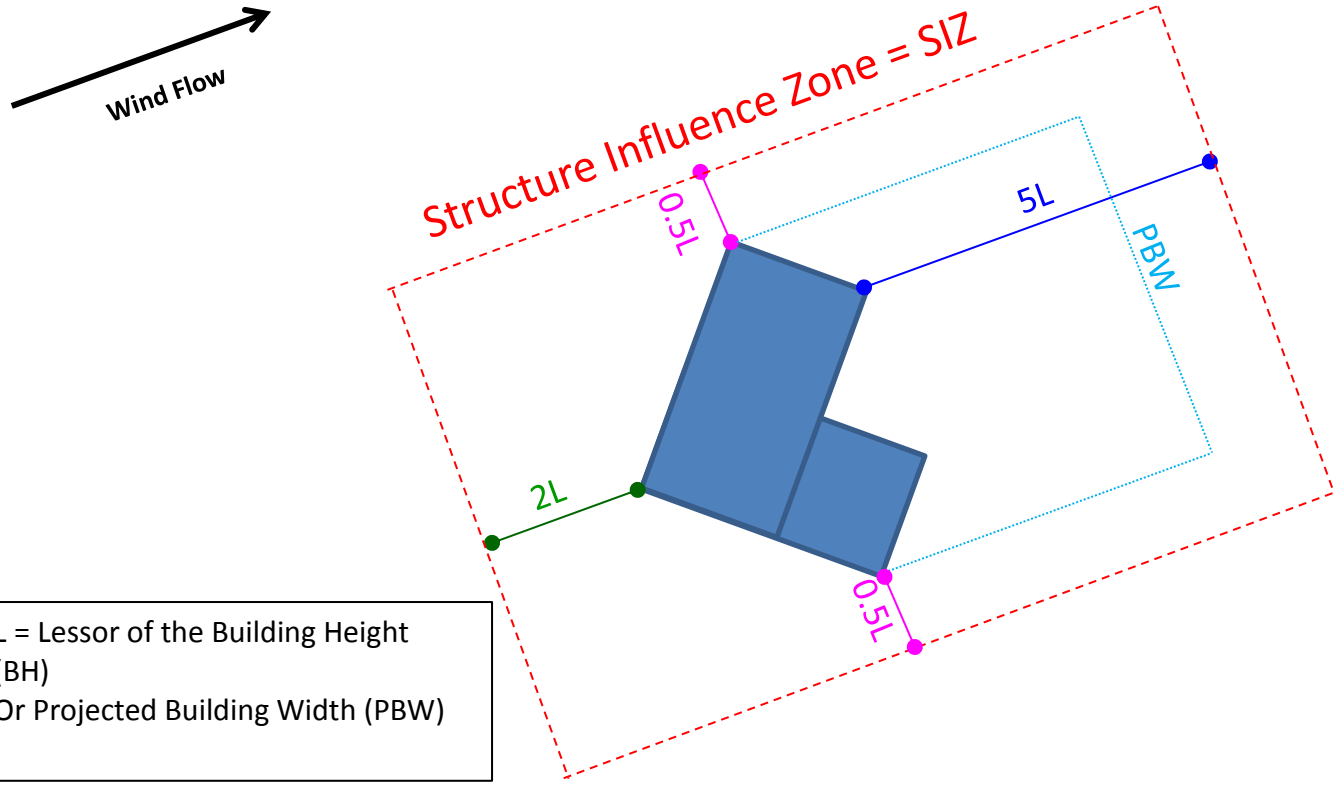
If a stack is less than the GEP stack height, building downwash effects should be taken into account within the model input file. Building downwash can occur if:

- Hs < Hb + 1.5L, where,
  - Hs = Stack Height
  - Hb = Building Height
  - L = Lesser of Hb or the Project Building Width (PBW)
  - PBW = Maximum length of a building that could affect air flow around and over a building or other obstacle.

In the downwind direction, if the distance between the stack and a building is <5L, downwash will be considered. Likewise, in the upwind direction, if the distance between the stack and a building <2L, downwash will be considered. Lastly, wake effect calculations will also be employed if the stack is located within 1/2L of the side of a building in the crosswind direction provided the stack is also within

5L downwind and 2L upwind of a building. Figure #2, entitled "Building Downwash, Structure Influence Zone" graphically depicts the area for which building downwash parameters are calculated.

Figure 2
Building Downwash
Structure Influence Zone



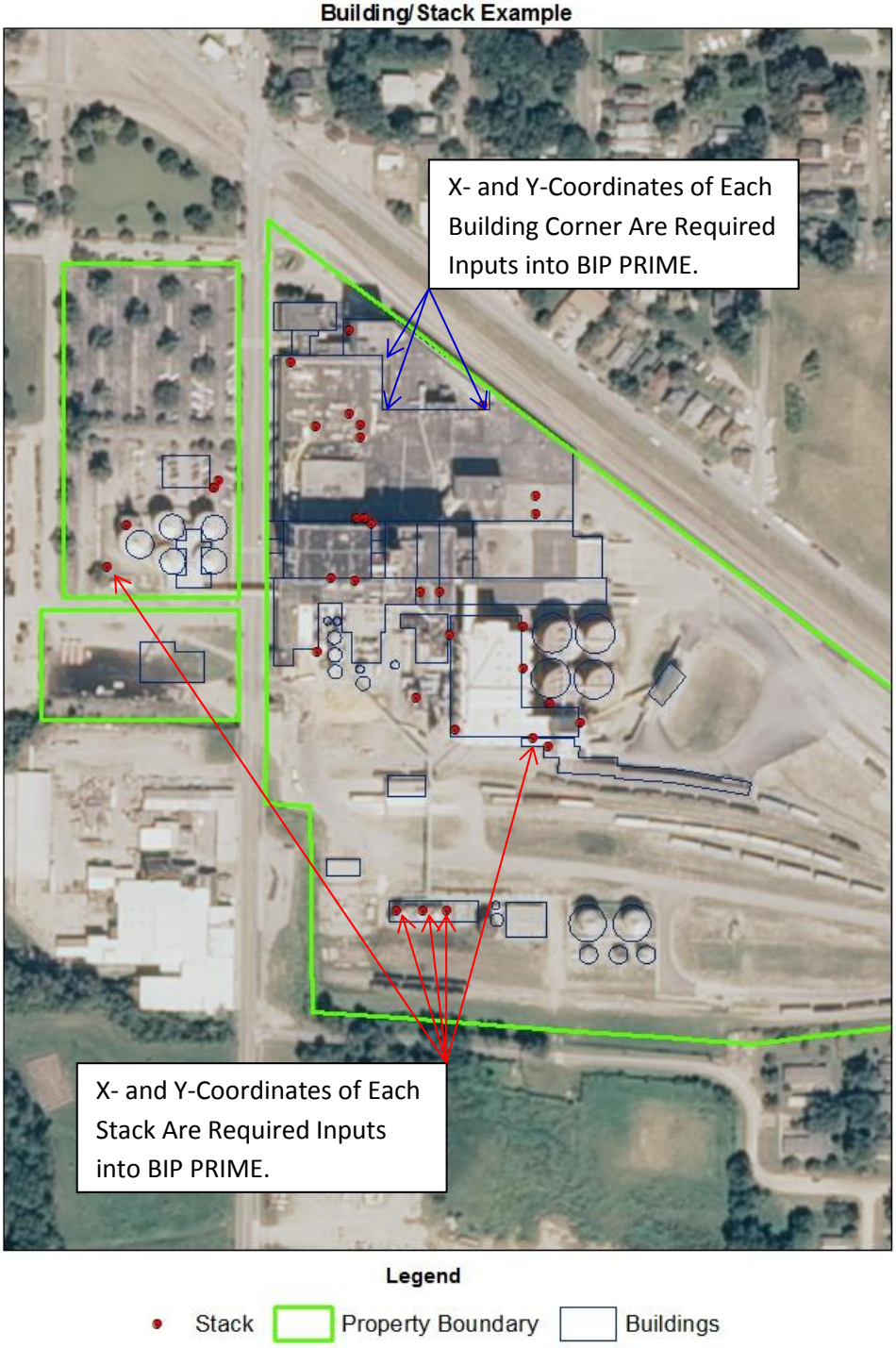
In order to provide a consistent method for applying downwash calculations for use in the air quality model, the Environmental Protection Agency developed a preprocessing tool referred to as the Building Profile Input Program (BPIP) with Plume Rise Model Enhancements (PRIME). The program is a PC-based program that was introduced to incorporate the GEP stack height requirements contained within Section 123 of the Clean Air Act and 40 CFR 51.1. The program produces AERMOD ready inputs for use with stack-driven, point source emission releases. ***It is important to note that building downwash effects are only considered for point source emission releases. Downwash effects for fugitive emission releases, such as volume and area sources, are not considered.***

In order to execute BPIP PRIME, the user must input the following information for each building and stack that is located at the facility under review:

- Building Inputs
  - Number of Tiers
  - Building Corner Coordinates for Each Building/Tier Combination
  - UTM Easting & UTM Northing
    - Zone 15
    - NAD83
  - Base Elevation Above Mean Sea Level
    - Meters
  - Height of the Structure Above Ground
    - Meters
- Stack Inputs
  - Coordinate for the Center of the Stack
    - UTM Easting & UTM Northing
    - Zone 15
    - NAD83
  - Base Elevation Above Mean Sea Level
    - Meters
  - Stack Height Above the Ground
    - Meters

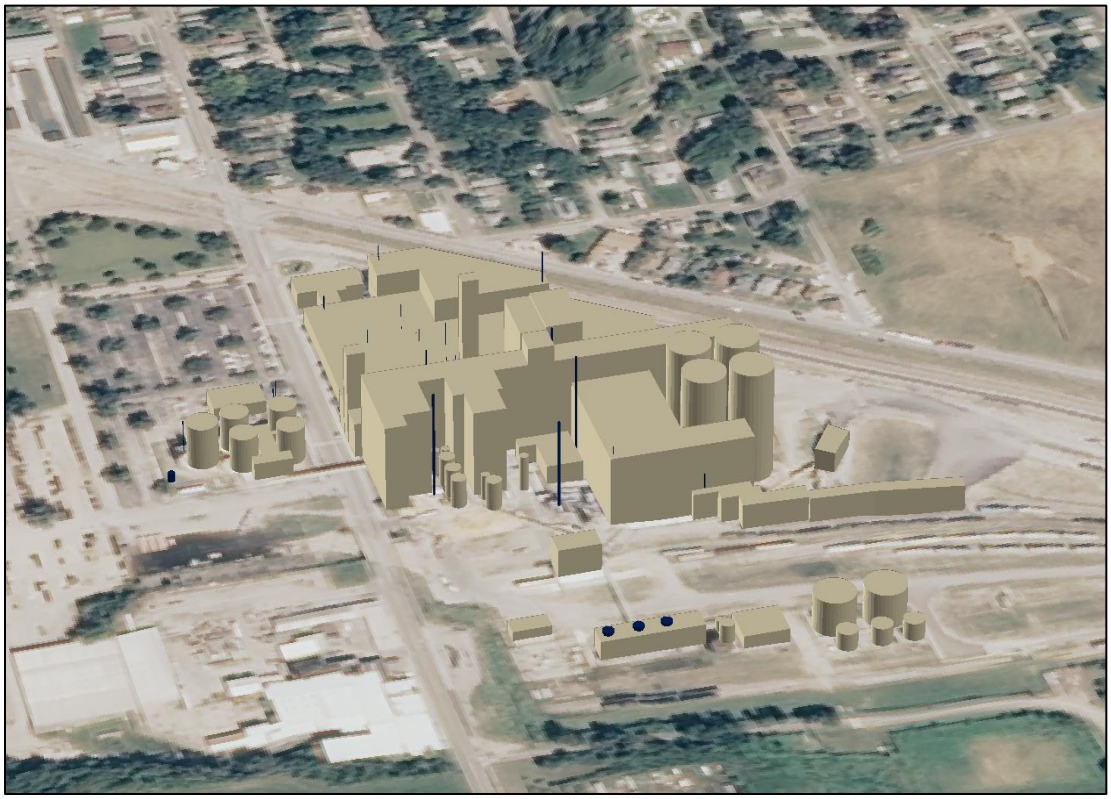
Figure 3, entitled "BPIP PRIME, Building/Stack Example," displays the building configuration and stack locations for a facility located within the State of Missouri. As noted previously, the applicant must obtain the UTM coordinates for each building corner and stack located within the zone of influence. If a building is comprised of multiple tiers, the applicant will have to obtain the UTM coordinates for each corner on a tier. Base elevations are also needed as an input element into the BPIP PRIME program.

Figure 3
BPIP PRIME
Building/Stack Example



Once obtained, the building corners and stack locations will be used to create the building/stack configuration that will be input into the BPIP PRIME model, refer to Figure 4, entitled "Modeled Building Configuration."

Figure 4
Modeled Building Configuration



Based upon the facility configuration, the BPIP PRIME program will determine if a stack is being subjected to wake effects from a surrounding structure or structures for each ten degree wind sector. If structure wake effects are evident, flags are set to indicate which stacks are affected by building wake zones. Once it is determined that a stack is influenced by a structure, BPIP PRIME will calculate the building heights and widths to be included in the dispersion model so that building downwash effects can be considered.

In addition, BPIP PRIME will calculate the GEP stack height for each stack in excess of 65-meters. If a stack exceeds the BPIP PRIME GEP stack height and was constructed after December 30, 1970, the height input into the air quality model must be limited to the BPIP PRIME calculated GEP stack height.